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Applicant : MATSUSHITA ELECTRIC IND CO LTD

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Inventor :

MATSUKAWA HIDEKI

SUMIDA SHIROU

YAMADA SATOSHI

INOUE KOJI

METHOD AND APPARATUS FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE

[Abstract]

PROBLEM TO BE SOLVED: To enhance uniformity in a gap surface, gap accuracy and alignment accuracy of a liquid crystal display device.

SOLUTION: This manufacturing method includes a process to form a seal pattern to seal a liquid crystal to one substrate 2b among a pair of substrates 2a, 2b having different sizes, capable of crimping the liquid crystal, a process to provide a pair surface plates 9, 10 at least one of which is freely displaced in the atmosphere adjusted to proper pressure, to set a

surface on which the seal pattern is formed inside, to install one substrate 2b on one surface plate 10 and to hold both dimensionally protruded end parts of the other substrate 2a by crimping them with the other surface plate 9 and a process to align preset markers provided on the pair of substrates 2a, 2b and to press the pair of surface plates 9, 10. An alignment process and a gap control process can be executed in the same continuous process without dividing them as in the conventional manner.

[Claims]

[Claim 1]

A method for fabricating an liquid crystal display (LCD) device comprising: forming a seal pattern for sealing liquid crystals at one of a pair of substrates each with a different size which can support liquid crystals therebetween; providing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates.

[Claim 2]

The method of claim 1, further comprising: spreading spacers defining a cell gap on at least one of the pair of substrates.

[Claim 3]

The method of claim 1, further comprising: providing a protrusion having a height that defines a cell gap on at least one of the pair of substrates.

[Claim 4]

The method of claim 1, further comprising: aligning the previously prepared marker on the pair of substrates, pressing the pair of base plates

and aligning them again.

[Claim 5]

A method for fabricating a liquid crystal display (LCD) device comprising: forming a seal pattern for sealing liquid crystals at one of a pair of substrates each with a different size that can support liquid crystals therebetween; dropping a required amount of liquid crystals on one substrate; installing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates.

[Claim 6]

The method of claim 5, further comprising: spreading spacers defining a cell gap on one of a pair of substrates, in which each spacer can have a specific diameter to obtain a desired cell gap.

[Claim 7]

The method of claim 5, further comprising: providing a protrusion having a height that defines a cell gap on at least one of a pair of substrates.

[Claim 8]

The method of claim 5, further comprising: aligning the previously prepared marker on the pair of substrates, pressing the pair of base plates and then aligning them again to enhance alignment precision.

[Claim 9]

An apparatus for fabricating a liquid crystal display (LCD) device as recited in claim 9 comprising: a vacuum tub whose pressure can be adjusted and a pair of base plates installed in the vacuum tub and having at least one side displaceable, a pair of substrates each with a different size that supporting liquid crystals therebetween being supported by the pair of base plates in a state that a surface with a seal pattern formed thereon faces inwardly, a previously prepared marker being aligned on the pair of substrates, and the both base plates being pressed, wherein a chuck is provided at numerically protrusive both end portions of one substrate of at least one base plate to maintain the both end portions.

[Title of the Invention]

APPARATUS AND METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY DEVICE

[Detailed description of the Invention]

[Field of the Invention]

The present invention relates to an apparatus and method for fabricating a liquid crystal display (LCD) device.

[Description of the Prior Art]

In a related art LCD fabrication process, a method for injecting liquid crystal into a liquid crystal cell includes an injection method and a dropping method. The injection method, which is commonly used for mass production, charges liquid crystal from an opening of an empty cell by using a capillary phenomenon in vacuum and a pressure difference. The dropping method is dropping liquid crystal on one substrate and bonding it with the other substrate in vacuum. Each method completes a liquid crystal panel through a process of bonding the pair of substrates.

Figure 9 is a flow chart of a process of the LCD device fabricated by the related art injection method.

The LCD device fabricated according to the flow chart has the sectional construction as shown in Figure 8. That is, a spacer 4 spreads to form a certain gap between a pair of substrates 2a and 2b having display electrodes 5a and 5b formed, respectively, thereon, and liquid crystal 3 is charged to fill the gap. At both sides of the pair of substrates 2a and 2b, a

polarization plate or an optical film can be installed at an optimum position. One or two sheets of the polarization plate can be used, or the polarization plate may not be used according to a principle mode.

In case of a transmission type LCD device 1 with such a structure, 3 wavelength type cold cathode tube radiates light to display an image from the opposite of a display surface, and in case of a reflection type LCD device, a reflection plate is installed at the opposite side of the display surface to brighten by using an external light to allow user's viewing. In this manner, the LCD device 1 can be voltage-driven to display an image.

A related art method for fabricating the LCD device 1 will now be described with reference to Figure 9. In the injection method, the substrates 2a and 2b having the display electrodes 5a and 5b are washed (P51), coated with a liquid-phase alignment material through offset printing to form alignment films 7a and 7b through first firing and then second firing (P52), on which aligning is performed through rubbing (P53). In general, after rubbing, the structure is washed with water in order to remove a foreign material or dirt from the surface (P54).

A sealant 6 for sealing liquid crystal 3 on one substrate, for example, the substrate 2a, is coated through drawing or screen printing to form a seal pattern (P55a). A UV resin for a temporary fixing is spot-printed by using a dispenser at other region than the region of the LCD device 1. In order to form a gap at the other substrate 2b, a spacer with a certain size spreads (P55b), and then, the both substrates 2a and 2b are bonded in the air (P56). When the two substrates 2a and 2b are bonded, bonding marks provided on electrodes of both substrates 2a and 2b are optically recognized. Thus,

when the bonding marks are conformed, the UV resin for the temporary fixing is irradiated with ultraviolet rays so as to be hardened.

In order to control the gap of the LCD device 1, the pair of substrates 2a and 2b are entirely pressed by an air press, and then, when an optimum gap is obtained, the sealant 6 is hardened (P57). In this case, if a thermosetting sealant is used, the sealant 6 is hardened by applying heat by a heater wire installed in a base plate of the air press (not shown). In case of using a UV -hardening sealant, generally, a transparent thick plate such as glass or acrylic material is used as the base plate for performing the air press. When an optimum gap is obtained, ultraviolet rays are irradiated from an outside of the base plate to harden the sealant 7, which is the commonly used method.

Thereafter, a glass portion of a non-display region of the substrate is divided and cut (P58), and according to the injection method, a created empty cell and liquid crystal 3 are put as a pool in a vacuum tub, liquid crystal is put from an inlet part of the empty cell at the degree of 0.2x133.322Pa to 0.7x133.322Pa, the interior of the vacuum tub is opened in the air, and then, the liquid crystal 3 is charged in the empty cell (P59). The sealing opening is covered with a resin (P60), the liquid crystal 3 attached to the LCD device 1 is washed, and then, the entire LCD device is annealed to perform re-alignment processing on the liquid crystal 3.

[Problems to be solved by the Invention]

However, in the related art method of fabricating the LCD device 1, when the empty cell is fabricated, the heating press or the UV press is used

to obtain the optimum gap, but in this case, it is not possible to obtain alignment with sufficiently high precision or uniformity of a surface of the gap. In the situation where the size of the substrate is increasing, obtaining high precision becomes problematic.

Namely, as for the bonding method for fabrication of the LCD device, in optimizing the gap precision while maintaining the favored precision of the alignment of the pair of the substrates with the same size, the following problems arise.

First, since the alignment process and the pressing process for generation of the gap are divided, it is difficult to create a suitable empty cell. That is, the UV resin temporarily fixed in the alignment process can come off by the forcible force of the pressing press in a follow-up process, and the alignment precision of the marks on the pair of substrates does not correspond, making it difficult to assemble them properly.

In addition, although the pair of substrates are bonded and temporarily fixed with good alignment precision, because the sealant is the thermosetting resin in the following seal hardening process, the alignment positions miss each other due to a difference of a linear expansion coefficient between the pair of substrates made of glass and the sealant inserted therebetween according to temporal duration of the heating press and a change in a temperature of the LCD device, failing to obtain the proper bonding precision. This problem becomes more serious as the size of the substrate is increasing.

Meanwhile, when the UV resin is used as the sealant, ultraviolet rays are irradiated from the outside of the transparent base plate in a state that

the gap is once formed by the pressing press. In this case, as the operation sheets are increasing, the base plate is heated by radiant heat according to irradiation of the ultraviolet rays, increasing the temperature of the substrate contacting with the base plate, whereas there is no temperature change at the other substrate. Accordingly, if the sealant is hardened between the pair of ultraviolet ray-irradiated substrates, the temperature difference between the pair of substrates makes the bonded substrates bent to cause gap non-uniformity of the LCD device. This problem becomes also severe as the size of the substrate increases.

In addition, when the pair of substrates are bonded in the vacuum tub, the substrates can be aligned with better precision compared with the related art case of bonding them in the atmospheric pressure, but once-established precision went amiss due to influence of the liquid crystal or the sealant provided between the pair of substrates.

In a different method for maintaining the substrates when bonding them in the vacuum tub, the substrates are adsorbed to be maintained at a lower value than a vacuum degree in the tub and the two substrates can be bonded in the same order. In this case, however, considering a limitation of the vacuum degree in the tub and the self-weight of the substrates with respect to a support force, strong adsorptive power can be hardly expected. In addition, when a process tact in mass production is counted, it can happen that the substrates may drop.

As stated above, the related art fabrication method cannot cope with a large-size substrate to come to make the proper alignment precision and gap precision compatible

Therefore, an object of the present invention is to solve the related art problems in line with the increase in the size of substrates such as a 20-inch or larger LCD device demanded for an LCD monitor substituting an existing CRT and provide a liquid crystal display device. and method capable of implementing a high quality display by obtaining a high precision of a narrow gap and enhancing uniformity of a gap surface, and capable of improving alignment precision and accomplishing a bright display device with a high aperture ratio.

[Means for solving the problem]

To achieve the above objects, there is provided a method for fabricating an LCD device as recited in claim 1 including: forming a seal pattern for sealing liquid crystal on one of a pair of substrates each with a different size which can support liquid crystal therebetween; providing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates.

Thus, by having the process of providing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting

numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates, the alignment process and the gap control process are performed successively in the same process without being divided as in the related art. Thus, shortcomings of the alignment precision and gap precision generated secondarily can be resolved. Accordingly, misalignment or missing of alignment due to generation of a gap does not occur and the LCD device would not be bent, and thus, mass production can be enhanced.

The method for fabricating an LCD device of claim 1 as recited in claim 2 includes: spreading spacers defining a cell gap on at least one of a pair of substrates. By having the process of spreading spacers defining the cell gap on at least one substrate of the pair of substrates, the spacer can have a specific diameter to obtain a desired cell gap.

The method for fabricating an LCD device of claim 1 as recited in claim 3 includes: providing a protrusion with a height defining a cell gap on at least one of a pair of substrates. By having the process of providing the protrusion with a height defining a cell gap on at least one substrate of the pair of substrates, the protrusion can have a defined height to obtain a desired cell gap. In addition, the protrusion is not inclined to be positioned at one side but formed at a non-pixel region to thereby enhance an aperture ratio.

The method for fabricating an LCD device of claim 1 as recited in claim 4 includes: aligning the previously prepared marker on the pair of substrates, pressing the pair of base plates and aligning them again, and

pressing the pair of base plates and aligning them again. By having the process of aligning the previously prepared marker on the pair of substrates, pressing the pair of base plates and aligning them again, alignment precision can be more enhanced.

A method for fabricating an LCD device as recited in claim 5 includes: forming a seal pattern for sealing liquid crystal at one of a pair of substrates each with a different size that can support liquid crystal therebewteen; dropping a required amount of liquid crystal on one substrate; installing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates.

Thus, by having the process of dropping a required amount of liquid crystal on one substrate; installing the pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting the numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning the previously prepared marker on the pair of substrates and pressing the pair of base plates, the alignment process and the gap control process are performed successively in the same process, without being divided, in the liquid crystal dropping method.

Thus, the shortcomings of the alignment precision and gap precision generated secondarily can be resolved. Accordingly, misalignment or missing of alignment due to generation of the gap does not occur and the LCD device would not be bent, and thus, mass production can be enhanced.

In addition, since a previously calculated amount of liquid crystal is dropped in the same process as the alignment process and the gap control process, higher gap precision can be obtained, and thus, the large size of the LCD anticipated to be demanded in the future or narrow gap can be accomplished.

Moreover, the dropping method is suitable for establishing an effective line for a tact, lead time, and the smallest amount of liquid crystal can be used.

The method for fabricating an LCD device of claim 5 as recited in claim 6 includes spreading spacers defining a cell gap on one of a pair of substrates, in which the spacer can have a specific diameter to obtain a desired cell gap.

The method for fabricating an LCD device of claim 5 as recited in claim 7 includes: providing a protrusion with a height defining a cell gap on at least one of a pair of substrates. By having the process of providing the protrusion with a height defining a cell gap on at least one of a pair of substrates, the protrusion can have a specific height to obtain a desired cell gap. In addition, the protrusion is not inclined to be positioned at one side, and is formed at a non-pixel region, to thereby increase an aperture ratio.

The method for fabricating an LCD device of claim 5 as recited in claim 8 includes: aligning a previously prepared marker on a pair of

substrates, pressing a pair of base plates and then aligning them again. Thus, alignment precision can be more enhanced.

An apparatus for fabricating an LCD device as recited in claim 9 includes: a vacuum tub whose pressure can be adjusted and a pair of base plates installed in the vacuum tub and having at least one side displaceable, a pair of substrates each with a different size that supporting liquid crystals therebetween being supported by the pair of base plates in a state that a surface with a seal pattern formed thereon faces inwardly, a previously prepared marker being aligned on the pair of substrates, and the both base plates being pressed, wherein a chuck is provided at numerically protrusive both end portions of one substrate of at least one base plate to maintain the both end portions.

Thus, by having the chucks for inserting numerically protruded both end portions of the substrates into one base plate and maintaining them, when the pair of substrates are bonded, adjusted in their position with a required precision and pressed to form a gap, an alignment difference or misalignment due to generation of the gap does not occur and the LCD device is not bent, and thus, mass production can be enhanced.

[Embodiment of the invention]

The first embodiment of the present invention will now be described with reference to Figures 1 to 3. Figure 1 is a schematic view of an apparatus for fabricating an LCD device in according with the first embodiment of the present invention.

As shown in Figure 1, the apparatus for fabricating the LCD device

includes a vacuum tub 8 whose pressure can be adjusted and a pair of base plates 9 and 10 installed in the vacuum tub 8 and having at least one side displaceable, in which a pair of substrates 2a and 2b each with a different size that support liquid crystal therebetween are supported by the pair of base plates 9 and 10 in a state that a surface with a seal pattern formed thereon face inwardly, a previously prepared marker is aligned on the pair of substrates 2a and 2b, and the both base plates 9 and 10 are pressed. In addition, a chuck 11 is provided at numerically protrusive both end portions of the substrate 2a of at least one base plate 9 to maintain the both end portions.

The LCD device fabricated by the fabricating apparatus has such sectional structure as shown in Figure 8. Namely, spacers 4 spread to form a certain gap between the pair of substrates 2a and 2b each with a different size and with respective display electrodes 5a and 5b therein, liquid crystal 3 is charged to fill the cell gap. A polarization plate (not shown) or other optical film can be installed at an optimized portion of both sides of the substrates 2a and 2b. The substrates 2a and 2b can be a color filter substrate, an array substrate with active devices arranged thereon, or a substrate with a transparent electrode formed thereon.

In order to make the cell gap have a certain value, spherical or bar type spacers 4 made of a resin group such as benzoguanamine or the like, and in order to enhance gap uniformity, the spacers 4 can be fixed on the substrate 2a or 2b. a sealant 6 is coated in the vicinity of the LCD device 1. The sealant 6 includes a thermosetting type made of an epoxy resin, or an ultraviolet-hardening type such as a radical or a positive ion type.

The size of the substrates used in this embodiment can have a combination of 5 types as shown in Figure 2. In case of (a), (b) and (e) types, a longer side of the substrate 2a is longer than the substrate 2b, and in case of (c), (d) and (e), a shorter side of the substrate 2a is longer than the substrates 2b. No matter how they are combined to overlap, the protruded side is taken.

A method for fabricating the LCD device 1 by using an injection method will now be described. Figure 3 is a flow chart of a method for fabricating the LCD device in accordance with the first embodiment of the present invention.

As shown in Figure 3, after the substrates 2a and 2b are washed (P1), a liquid-phase alignment material is offset-printed on the substrates 2a and 2b and then dried at a high temperature to form alignment films 7a and 7b (P2). The surface of the alignment film on the substrate is rubbed by using a buff (P3), and if there is a foreign material on the surface, the substrate is washed (P4). The sealant 6 is coated on one of the thusly formed substrates, for example, on the substrate 2b, through drawing or printing to form a seal pattern (P5a), and then, spacers 4 spread uniformly on the substrate 2b or on the other substrate 2a (P5b). The conductive resin is coated by using a dispenser in a spotting manner.

And then, the substrates 2a and 2b are bonded by using the apparatus as shown in Figure 1. The apparatus is a pressing apparatus having the pair of upper and lower base plates 9 and 10 whose at least one side can be displaceable in the vacuum tub 8, and a recognition camera for allowing alignment therein.

First, one of the substrates, for example, the substrate 2b is installed on the lower base plate 10. Chucks 11 for maintaining the numerically exceeding both ends of the substrate 2a with the substrate 2a interposed therebetween is maintained at the upper base plate 9. After the interior of the vacuum tub 8 is adjusted to have a certain pressure, the upper and lower base plates 9 and 10 are pressed to bond the both substrates 2a and 2b. And then, the upper and lower substrates 2a and 2b are adjusted in their position with required precision while checking position alignment of marks of the substrates 2a and 2b, and the interior of the vacuum tub 8 is returned to an atmospheric pressure (P6). During this operation, the substrate 2a maintained by the base plate 9 is not allowed to be separated from the base plate 9. Thereafter, the sealant is hardened or pre-hardened to form the LCD device 1 (P7).

The chucks 11 with the substrate 2a interposed therebetween are mounted at the base plate 9, maintaining both sides of the substrate 2a free from a self-weight of the substrate 2a which are inserted in the chucks. The substrates 2a and 2b can be the array substrate or the color filter substrate which is made of a material such as plastic or film.

In the following process, in order to form an empty cell, the periphery of the substrates 2a and 2b are divided and cut (P8), and the empty cell and a liquid crystal storing unit are prepared in the vacuum tub. And then, when the vacuum degree in the vacuum tub is stabilized to a degree, a sealing opening of the empty cell is put in the liquid crystal storing unit to return the interior of the vacuum tub to the atmospheric pressure, and liquid crystal 3 is injected into the cell gap by virtue of a different pressure between the

inside and the outside of the empty cell and a capillary phenomenon (P9). If a small amount of liquid crystal is used, the sealing opening is covered by a resin (P10), extra liquid crystal 3 is washed out, the LCD device 1 is entirely annealed, and then, the liquid crystal 3 is re-aligned (P11).

In this manner, without discriminating the alignment process and the gap control process as in the related art, in this embodiment, the two processes are performed in the successive same process, and the shortcoming of the alignment precision and gap precision which has been secondarily generated in the related art can be resolved.

The second embodiment of the present invention will now be described with reference to Figures 4 and 5. Figure 4 is a sectional view of the LCD device fabricated according to the fabricate method in the second embodiment of the present invention.

Protrusions 12 are provided to form a certain gap between a pair of substrates 2a and 2b each with a different size. The protrusion 12 can be patterned by using a photosensitive material of an acrylic group or formed by overlapping with one of R, G, B and BM of a color filter. The protrusion 12 serves as the spacer 4. In order to obtain a high aperture ratio, the protrusion 12 is formed at a non-pixel region. As for the number (density) of protrusions 12, uniformity of the cell gap can be obtained as the number of protrusions 12 increases. But in terms of reliability, when the protrusion is left at a low temperature of below 0°C, air bubbles are generated from the relation between capacity in the cell and a coefficient of expansion of a liquid crystal material. Thus, the density of the protrusions 12 and the gap uniformity of the liquid crystal panel and generation of air bubbles at the low

temperature have a relation of being traded off. Likewise, the size and hardness of a material of the protrusion 12 also have the relation of trading off with the density of the protrusion 12.

A process for forming the protrusion 12 will now be described. In general, it is easy to form the protrusion 12 as the same time when the color filter is formed. But, in this case, generation of non-uniformity of film thickness around the protrusion according to printing of an alignment film or defective alignment with a stripe in a follow-up process may degrade the contrast. However, display deficiency can be restrained according to a shape, a size or a position of the protrusion 12. Meanwhile, in a different method, the protrusion 12 can be formed after rubbing, which, however, can degrade alignment power because of using the photolithography.

As shown in Figure 4, the substrate 2b with the protrusion 12 is used. The liquid crystal 3 is charge to fill the gap between the substrates 2a and 2b each having a different size. A polarization plate (not shown) or other optical film is installed at an optimum position at both sides of the substrates 2a and 2b. The substrates 2a and 2b can include a color filter substrate, an array substrate with active devices arranged thereon or a substrate with a transparent electrode formed thereon. The sealant is coated at the periphery of the LCD device. The sealant 6 includes a thermosetting type made of an epoxy resin or an ultraviolet-hardening type such as radical or positive ion type.

A method for fabricating the LCD device 21 using the injection method will now be described.

Figure 5 is a flow chart of a method for fabricating the LCD device in

accordance with the second embodiment of the present invention. As shown in Figure 5, likewise in the first embodiment of the present invention, the sealant 6 or a conductive resin is coated to be formed (P1 to P15a). The protrusion 12 is formed as described above (P15b). The substrates 2a and 2b each with a different size are bonded by using the apparatus as illustrated in Figure 1. Likewise in the first embodiment, the apparatus illustrated in Figure 1 is a press apparatus having the pair of base plates 9 and 10 in the vacuum tub 8. The press apparatus also includes a recognition camera for allowing alignment. As for a maintaining method, the substrate 2b is installed on the base plate 10, both ends of the substrate 2 with a larger size are inserted into the chucks 11 attached at the upper base plate 9, and in this state, the upper base plate 9 is pressed to bond the both substrates 2a and 2b. At this time, the both substrates are positioned as necessary while checking position matching of markers of the upper and lower substrates 2a and 2b (P6). The interior of the vacuum tub 8 is returned to an atmospheric pressure to harden or pre-harden the sealant to thereby form the LCD device 1 (P7).

In order to form an empty cell, the periphery of the substrates 2a and 2b are cut (P8), and the empty cell and a liquid crystal storing unit are prepared in the vacuum tub. And then, when the vacuum degree in the vacuum tub is stabilized to a degree, a sealing opening of the empty cell is put in the liquid crystal storing unit to return the interior of the vacuum tub to the atmospheric pressure, and liquid crystal 3 is injected into the cell gap by virtue of a different pressure between the inside and the outside of the empty cell and a capillary phenomenon (P9). If a small amount of liquid

crystal is used, the sealing opening is covered by a resin (P10), extra liquid crystal 3 is washed out, the LCD device 1 is entirely annealed, and then, the liquid crystal 3 is re-aligned (P11).

The third embodiment of the present invention will now be described with reference to Figure 6. Figure 6 is a flow chart of a method for fabricating an LCD device by using a dropping method in accordance with the third embodiment of the present invention.

As shown in Figure 6, the order (P1 to P3) of the processes until the substrates 2a and 2b with the alignment films 7a and 7b formed thereon, each having a different size, are rubbed, are the same as the injection method as shown in Figure 3. If there is a foreign material on the surface, a washing process is performed after performing rubbing (P4).

The sealant 6 can be applied to or coated through printing on one substrate 2b of the thusly formed substrates (P25a) and spacers 4 spread uniformly on the other substrate 2a (P25b). As the sealant 6, the radical type or the positive ion type UV resin is used. As the spacer 4, an adherent type spacer is used to be formed, which is expected to have certain attachment strength with the substrate 2a. If the spacer 4 is not used, the method for providing the protrusion 12 in advance on the substrates 2a and 2b as stated above in the second embodiment of the present invention. Herein, the spacer 4 is used to be adhered (P26b). And, a conductive resin is coated on a conductive land portion in a spotting manner by using a dispenser.

Next, liquid crystal 3 is dropped preferably on the substrate 2b on which the sealant 6 has been coated. In this case, the amount of liquid crystals 3 to be dropped can be calculated in advance from the display area

and gap thickness of the LCD device 1, a pattern suitable for making liquid crystals 3 spread uniformly is prepared, and defoaming-finished liquid crystals 3 are dropped (P26a).

The substrates 2a and 2b each with a different size are bonded by using an assembly apparatus. As shown in Figure 1, the apparatus is a pressing apparatus which includes the pair of base plates 9 and 10 whose at least one side can be displaceable in the vacuum tub 8, and a recognition camera for allowing alignment. The substrate 2b on which the liquid crystal 3 has been dropped is installed on the lower base plate 10. The numerically exceeding both ends of the substrate 2a with the substrate 2a are inserted into chucks 11 previously provided at the upper base plate 9 so as to be maintained. After the interior of the vacuum tub 8 is adjusted to have a certain pressure, the upper and lower base plates 9 and 10 are pressed to bond the both substrates 2a and 2b. And then, markers of the substrates 2a and 2b are matched in their position to obtain a certain bonding precision position and the interior of the vacuum tub 8 is returned to the atmospheric pressure (P6). In addition, when the markers are matched in their position, it can be temporarily fixed in the spotting manner. Thereafter, ultraviolet rays are irradiated only to the sealant 6 between the both substrates 2a and 2b each with a different size to harden the sealant 6 (P7). For this purpose, there is a masking in a display region or a laser optical radiation.

Finally, the liquid crystal 3 is re-aligned through an annealing process (P11) and the substrates 2a and 2b are divided and cut to form the LCD device 1 (P8).

The fourth embodiment of the present invention will now be

described with reference to Figure 7. Figure 7 is a flow chart of a method for fabricating an LCD device using a dropping method in accordance with the fourth embodiment of the present invention.

As shown in Figure 7, the order (P1 to P3) of the processes until the substrates 2a and 2b with the alignment films 7a and 7b formed thereon, each having a different size, are rubbed, are the same as the injection method as shown in Figure 3. If there is a foreign material on the surface, a washing process is performed after performing rubbing (P4). Each process of seal printing (P35a), liquid crystal dropping (P36a), spacer spreading (P35b) and spacer adhering (P36b) is the same as those in the third embodiment.

The substrates 2a and 2b each with a different size are bonded by using an assembly apparatus. As shown in Figure 1, the apparatus is a pressing apparatus which includes the pair of base plates 9 and 10 whose at least one side can be displaceable in the vacuum tub 8, and a recognition camera for allowing alignment. The substrate 2b on which the liquid crystal 3 has been dropped is installed on the lower base plate 10. The numerically exceeding both ends of the substrate 2a with the substrate 2a are inserted into chucks 11 previously provided at the upper base plate 9 so as to be maintained. After the interior of the vacuum tub 8 is adjusted to have a certain pressure, the upper base plate 9 is lowered down to make the substrates 2a and 2b each with a different size approach. And then, markers of the substrates 2a and 2b are matched in their position to obtain a certain bonding precision position (P37), and the upper and lower base plates 9 and 10 are pressed (P38). And then, the markers are matched in their position

again (P39), and the interior of the vacuum tub 8 is returned to the atmospheric pressure (P6). In addition, when the markers are matched in their position, it can be temporarily fixed in the spotting manner. Thereafter, ultraviolet rays are irradiated only to the sealant 6 between the both substrates 2a and 2b each with a different size to harden the sealant 6 (P7). The liquid crystal 3 is re-aligned through an annealing process (P11) and the substrates 2a and 2b are divided and cut to form the LCD device 1 (P8).

In the method for fabricating the LCD device using the injection method as in the first and second embodiments of the present invention, the previously provided marks are aligned on the pair of substrates as in the fourth embodiment of the present invention, the pair of base plates are pressed and then aligned again.

[Effect of the invention]

According to the method for fabricating the LCD device as recited in claim 1, by having the process of providing a pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning a previously prepared marker on the pair of substrates and pressing the pair of base plates, the alignment process and the gap control process are performed successively in the same process without being divided as in the related art. Thus, shortcomings of the alignment precision and gap precision generated secondarily can be

resolved. Accordingly, misalignment or missing of alignment due to generation of a gap does not occur and the LCD device would not be bent, and thus, mass production can be enhanced.

In claim 2, by having the process of spreading spacers defining the cell gap on at least one substrate of the pair of substrates, the spacer can have a specific diameter to obtain a desired cell gap.

In claim 3, by having the process of providing the protrusion with a height defining a cell gap at at least one substrate of the pair of substrates, the protrusion can have a specific height to obtain a desired cell gap. In addition, the protrusion is not inclined to be positioned at one side but formed at a non-pixel region to thereby enhance an aperture ratio.

In claim 4, by having the process of aligning the previously prepared marker on the pair of substrates, pressing the pair of base plates and aligning them again, alignment precision can be more enhanced.

In claim 5, by having the process of dropping a required amount of liquid crystal on one substrate; installing the pair of base plates with at least one displaceable side in an atmosphere adjusted to have a suitable pressure, installing the seal pattern-formed substrate on one base plate such that the seal pattern-formed surface faces inwardly, and inserting the numerically protruded both end portions of the other substrate to the other base plate and maintaining them; and aligning the previously prepared marker on the pair of substrates and pressing the pair of base plates, the alignment process and the gap control process are performed successively in the same process, without being divided, in the liquid crystal dropping method. Thus, the shortcomings of the alignment precision and gap precision

generated secondarily can be resolved. Accordingly, misalignment or missing of alignment due to generation of a gap does not occur and the LCD device would not be bent, and thus, mass production can be enhanced. Accordingly, a high quality LCD device with high uniformity of the gap surface, high gap precision and high alignment precision can be fabricated.

In addition, since a previously calculated amount of liquid crystal is dropped in the same process as the alignment process and the gap control process, higher gap precision can be obtained, and thus, the large size of the LCD anticipated to be demanded in the future or narrow gap can be accomplished.

Moreover, the dropping method is suitable for establishing an effective line for a tact, lead time, and the smallest amount of liquid crystal can be used.

In claim 6, by having the process of spreading spacers defining a cell gap on one of the pair of substrates, the spacer can have a specific diameter to obtain a desired cell gap.

In claim 7, by having the process of providing the protrusion with a height defining a cell gap on at least one of a pair of substrates, the protrusion can have a specific height to obtain a desired cell gap. In addition, the protrusion is not inclined to be positioned at one side, and is formed at a non-pixel region, to thereby increase an aperture ratio.

In claim 8, by having the process of aligning the previously prepared marker on a pair of substrates, pressing a pair of base plates and then aligning them again, alignment precision can be more enhanced.

In claim 9, by having the chucks for inserting numerically protruded

both end portions of the substrates into one base plate and maintaining them, when the pair of substrates are bonded, adjusted in their position with a required degree and pressed to form a gap, an alignment difference or misalignment due to generation of the gap does not occur and the LCD device is not bent, and thus, mass production can be enhanced.

[Description of drawing]

Figure 1 is a schematic view of an apparatus for fabricating an LCD device in accordance with a preferred embodiment of the present invention;

Figure 2 illustrates combination of substrates each with a different size in preferred embodiment of the present invention;

Figure 3 is a flow chart of a method for fabricating an LCD device in accordance with a first embodiment of the present invention;

Figure 4 is a sectional view of an LCD device fabricated according to a fabrication method in accordance with the second embodiment of the present invention;

Figure 5 is a flow chart of a method for fabricating an LCD device in accordance with a second embodiment of the present invention;

Figure 6 is a flow chart of a method for fabricating an LCD device in accordance with a third embodiment of the present invention;

Figure 7 is a flow chart of a method for fabricating an LCD device in accordance with a fourth embodiment of the present invention;

Figure 8 is a sectional view of an LCD device; and

Figure 9 is a flow chart of a method for fabricating an LCD device in accordance with a conventional art.